Event-by-event charge/neutral fluctuation at RHIC-PHENIX

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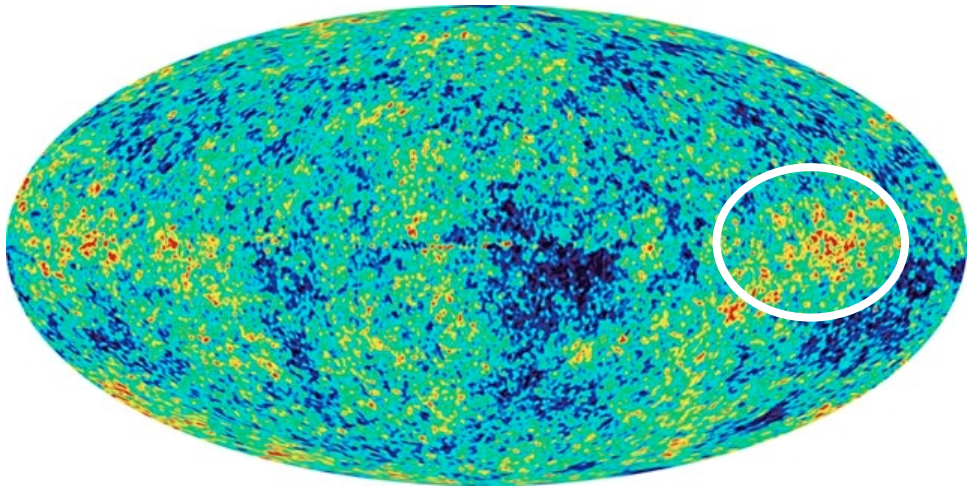
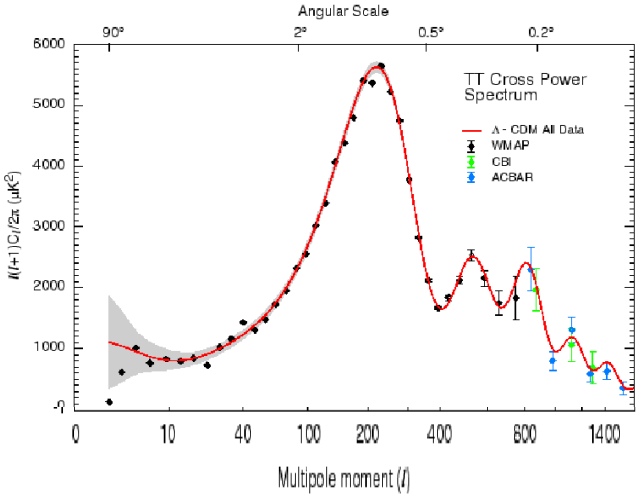
Why fluctuation ?



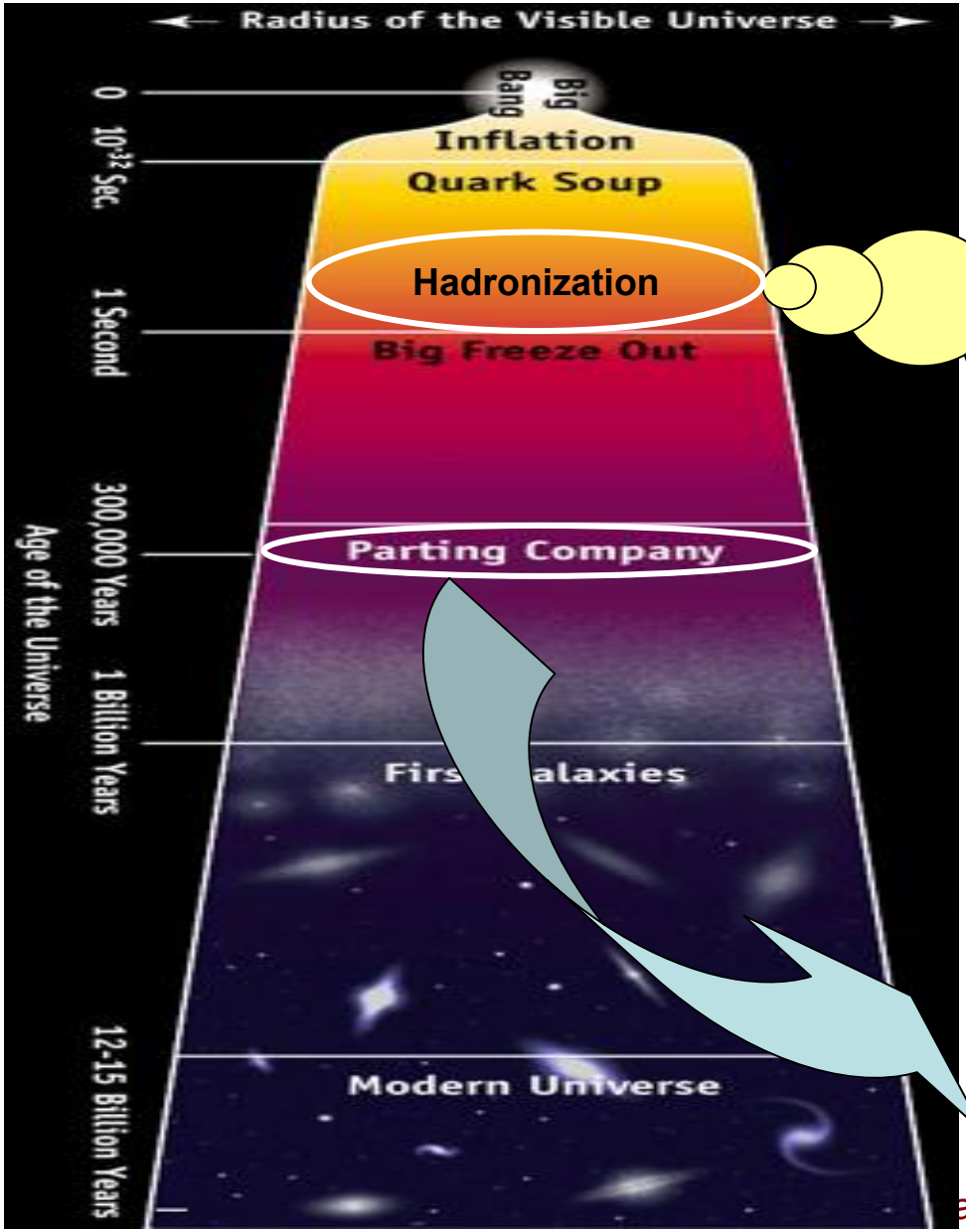
Measure maximum deviation size in homogeneous flux in our method



The Microwave Sky image from the WMAP Mission
http://map.gsfc.nasa.gov/m_mm.html

- Fluctuations carries information at early universe in cosmology despite of the only single Big-Bang event.
- Why don't we use the genuine event-by-event information by getting all phase space information to study evolution of dynamical system in Heavy Ion collisions ?
- We can firmly search for interesting fluctuations with more than million times of mini Big-Bangs.

Physics motivation

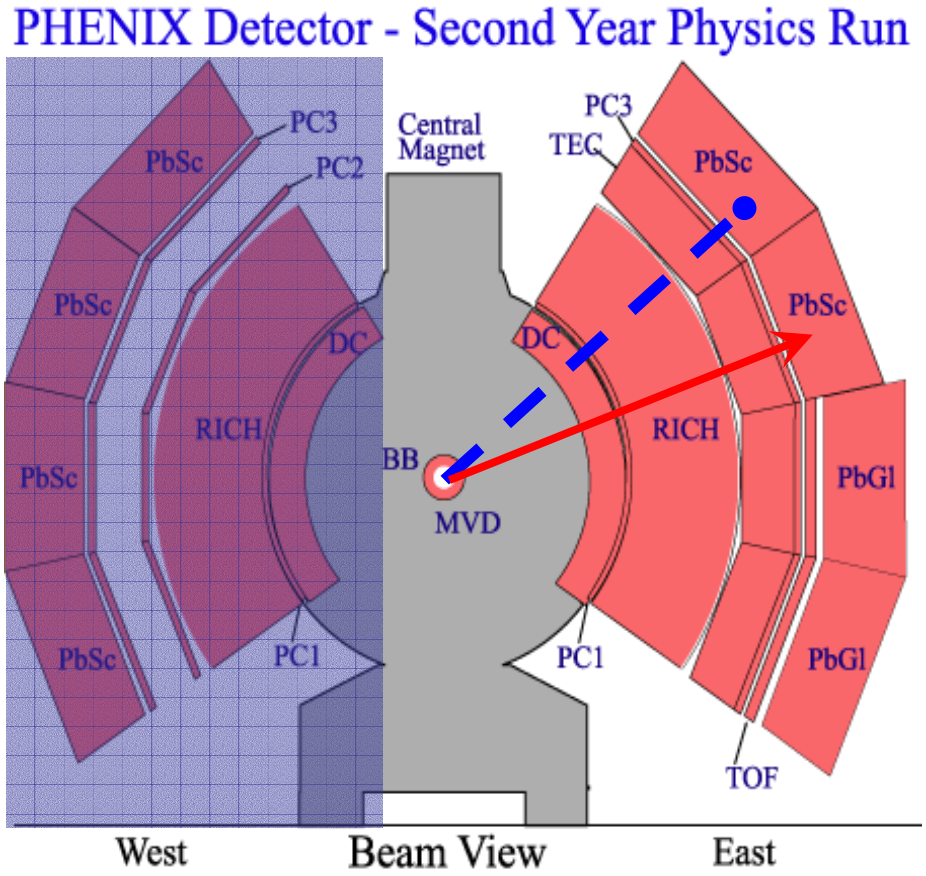


Fluctuation of charged and neutral π as charge/neutral balance is a possible probe to extract information at the chiral phase transition (…DCC scenario).

WMAP have seen the fluctuation of CMB at the recombination.

Au+Au $\sqrt{sNN} = 200$GeV at PHENIX

- **Using magnetic field-off**
- **Charged Track**
  Drift chamber, Pad chamber1 with BBC vertex
- **Photon Cluster**
  Electro-magnetic calorimeter
  - Cluster shower shape
  - Time of flight
  - association cuts by tracks
- **Precisely data quality assurance was necessary to reject detector effect!**

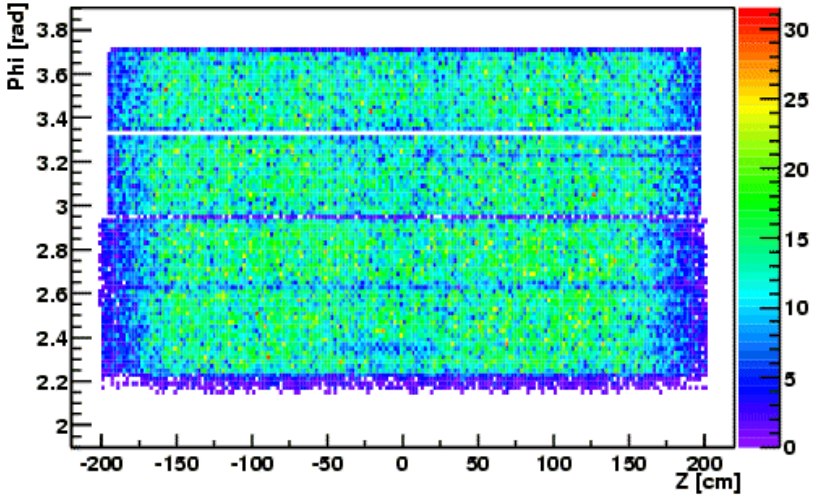


$$|\Delta\eta| < 0.35$$

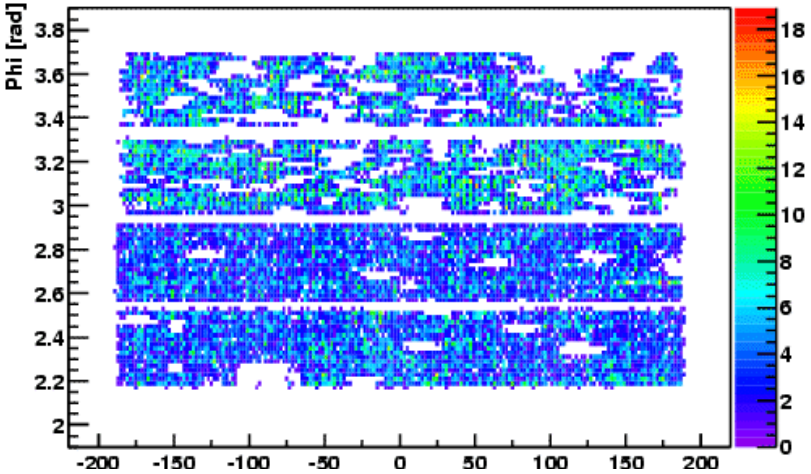
$$\Delta\phi < 1/2\pi$$

Event sample and a normal event

Charged tracks



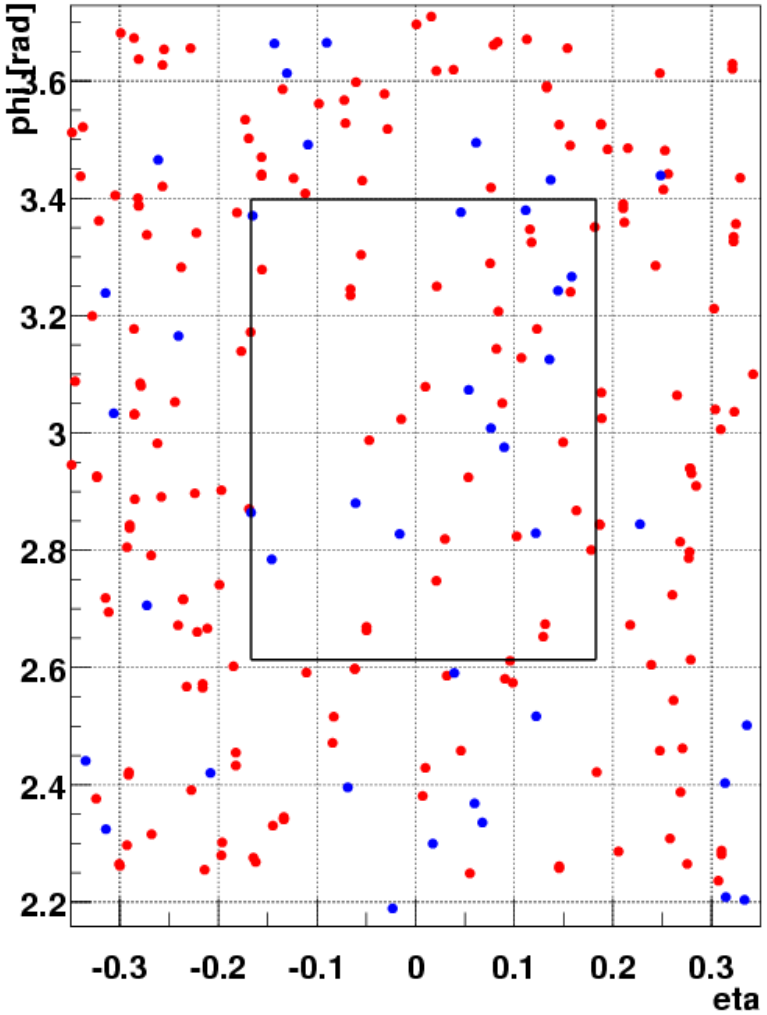
Photon clusters



~3,000 events accumulated

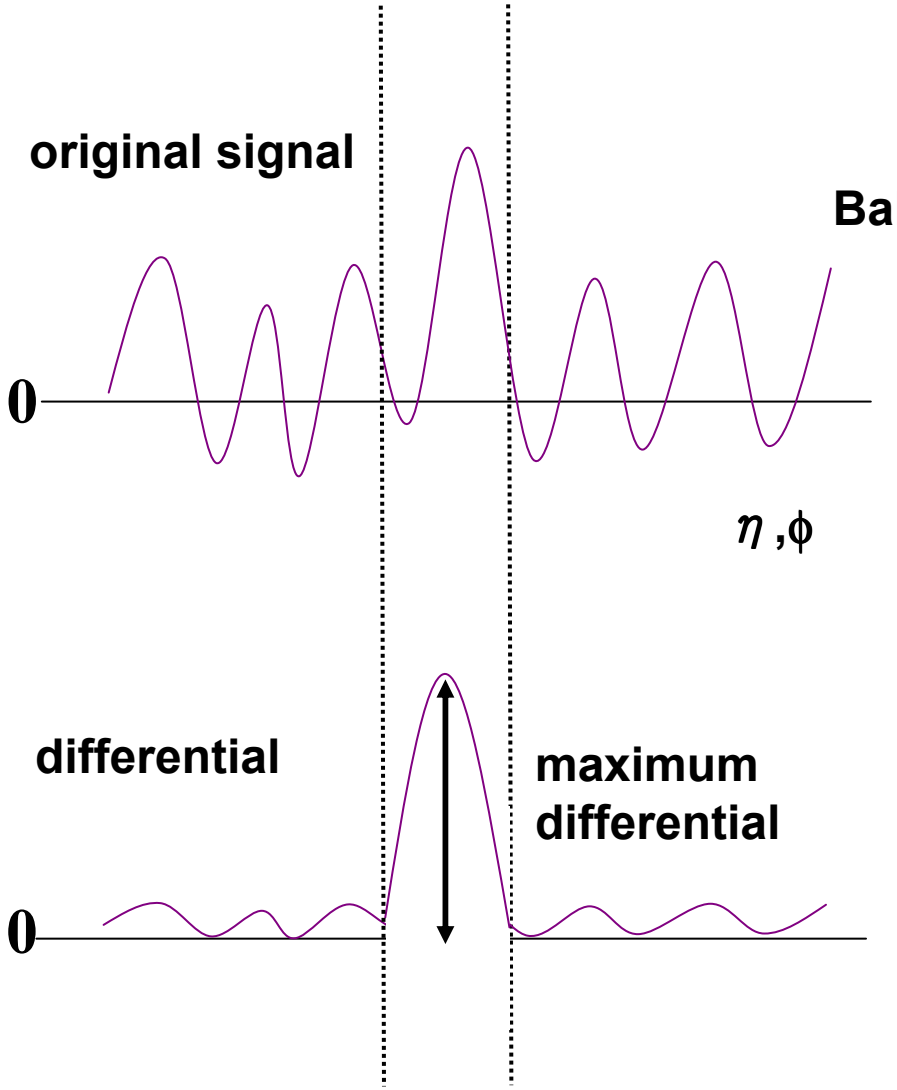
● **Charged track**

● **Photon cluster**



2.4 standard deviation

Observable



$$x \equiv (2^{-j_\eta}\eta, 2^{-j_\phi}\phi)$$

Balance $$B(x) \equiv N_{\pi^\pm}(x) - 2N_{\pi^0}(x)$$

$$\approx N_{ch}(x) - N_\gamma(x)$$

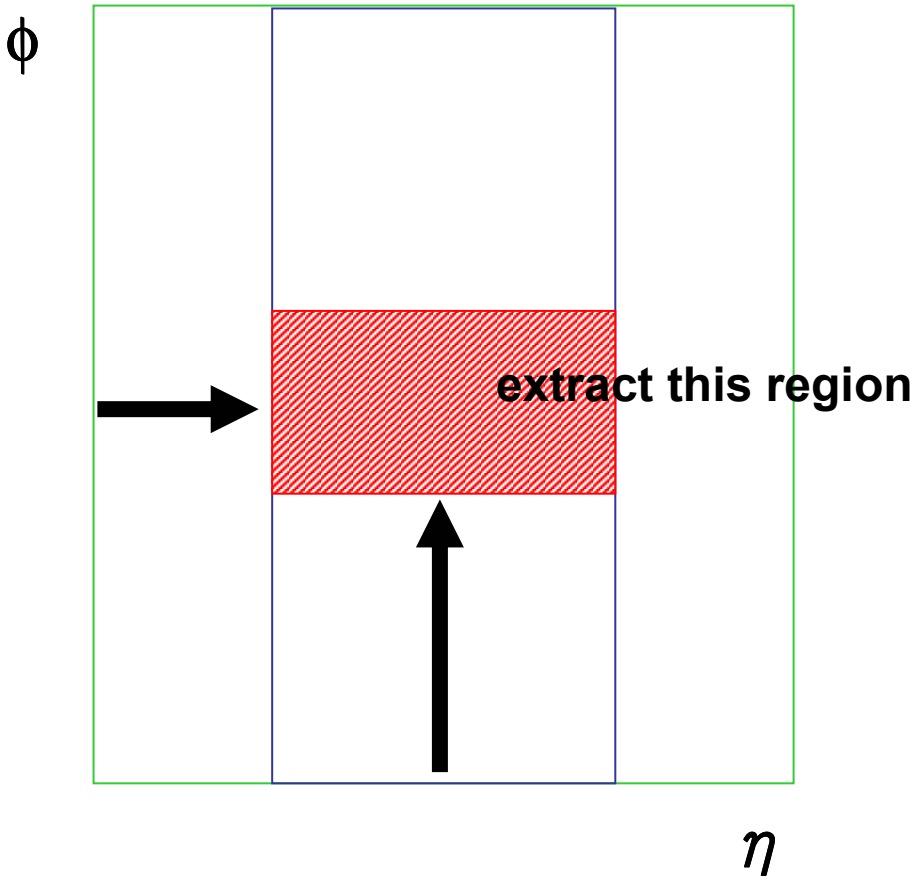
$$\langle B(x)\rangle \equiv \langle N_{ch}(x)\rangle - \langle N_\gamma(x)\rangle$$

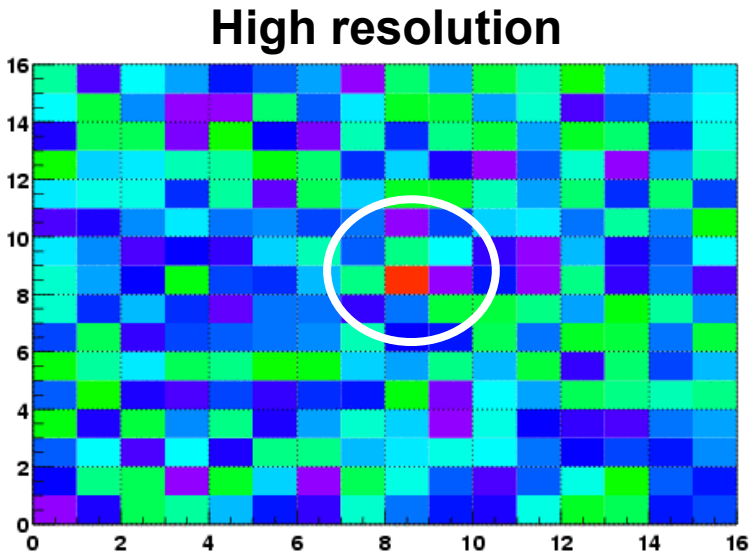
$$\sigma_{\langle B(x)\rangle} \equiv \sqrt{\delta\langle N_{ch}(x)\rangle^2 + \delta\langle N_\gamma(x)\rangle^2}$$

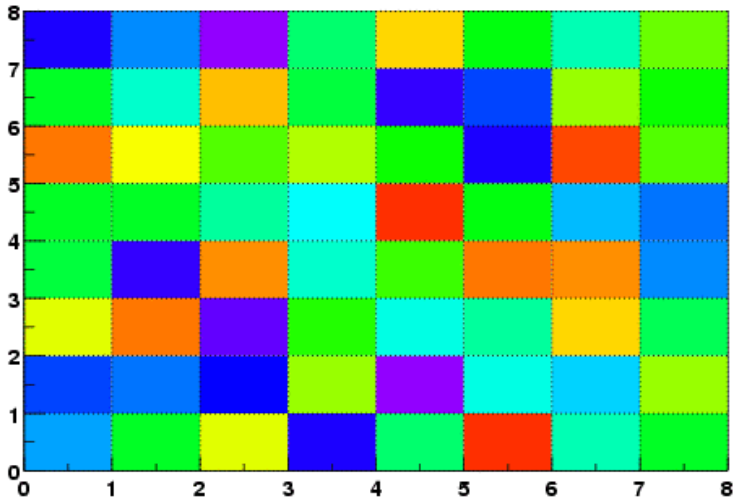
$$\delta B(x) \equiv \frac{B(x+dx) - B(x)}{\sigma_{\langle B(x)\rangle}}$$

$$\delta B_{\max} \equiv \max|\delta B(x)|$$

How to extract region?

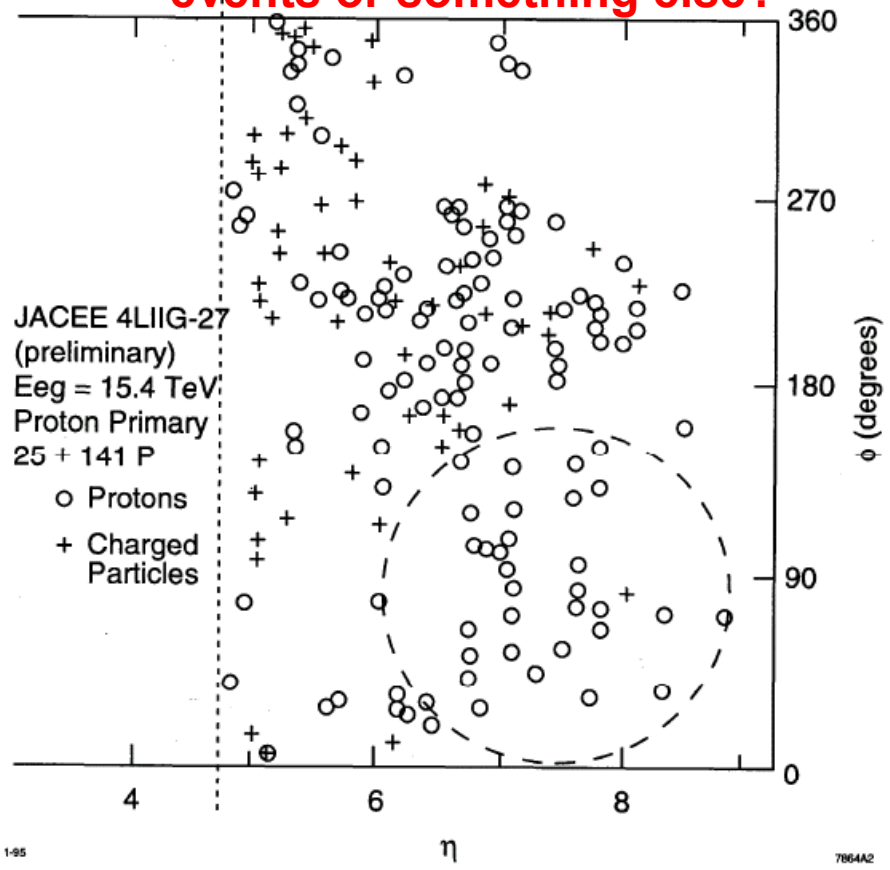






High energy cosmic ray experiment and PHENIX

Can DCC scenario explain these events or something else?

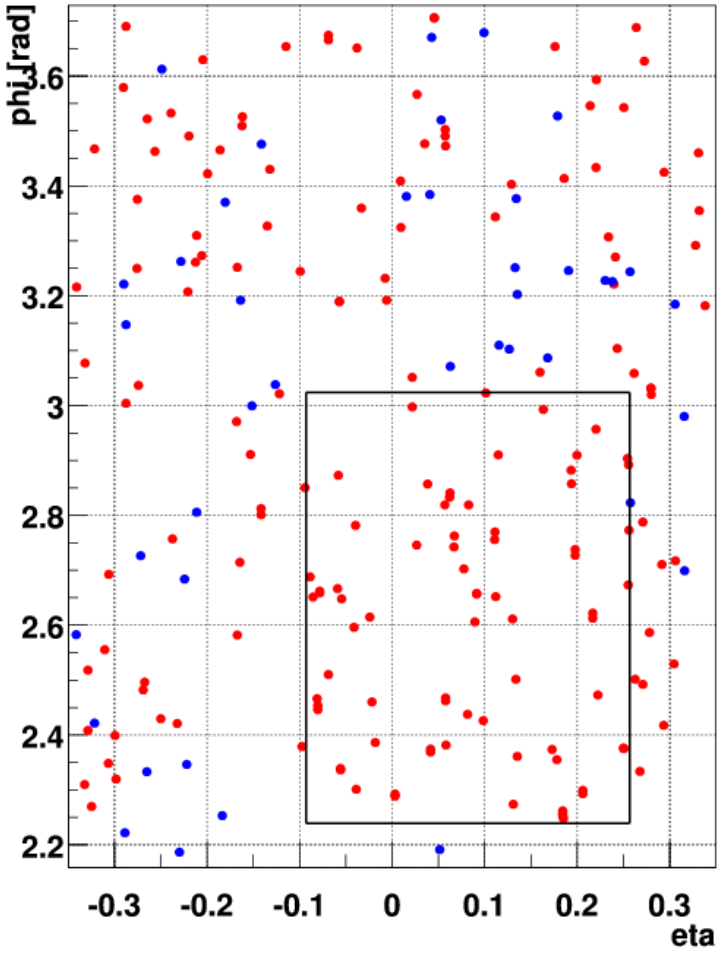


○: Photon

+ : Charged Particle

J. J. Lord and J. Iwai. Int. Conference on High Energy Physics, TX, 1992

PHENIX 7.24 standard deviation

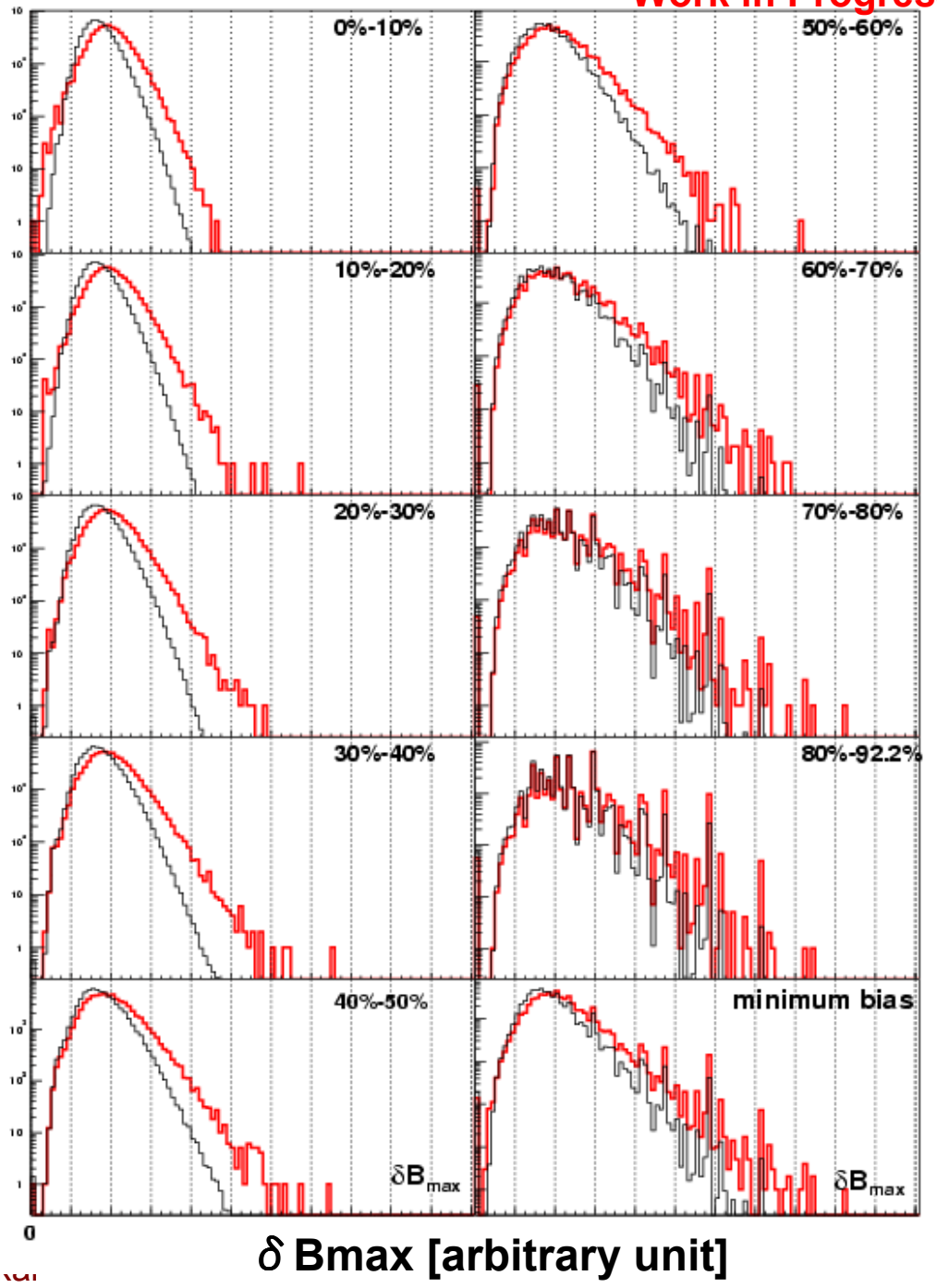


● **Charged track**

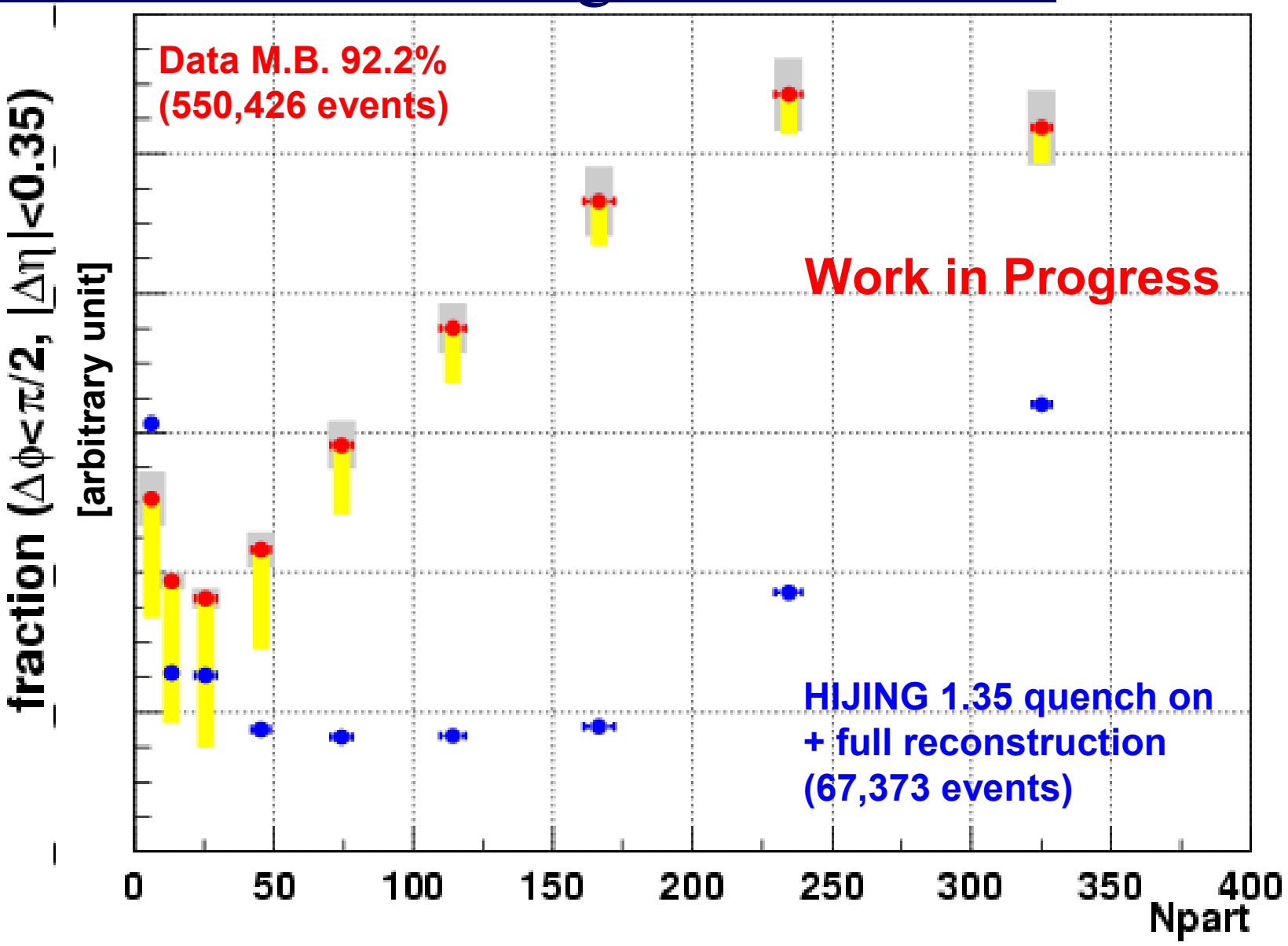
● **Photon cluster**

Maximum differential balance distributions

- **δ Bmax distribution (each centrality:10%) with base line fluctuation**
  - black : binomial sample, 100 times larger statistics than real data obtained by hit map
  - red : data



N-participant dependence of the event fraction above 5% significance level



Summary and plan

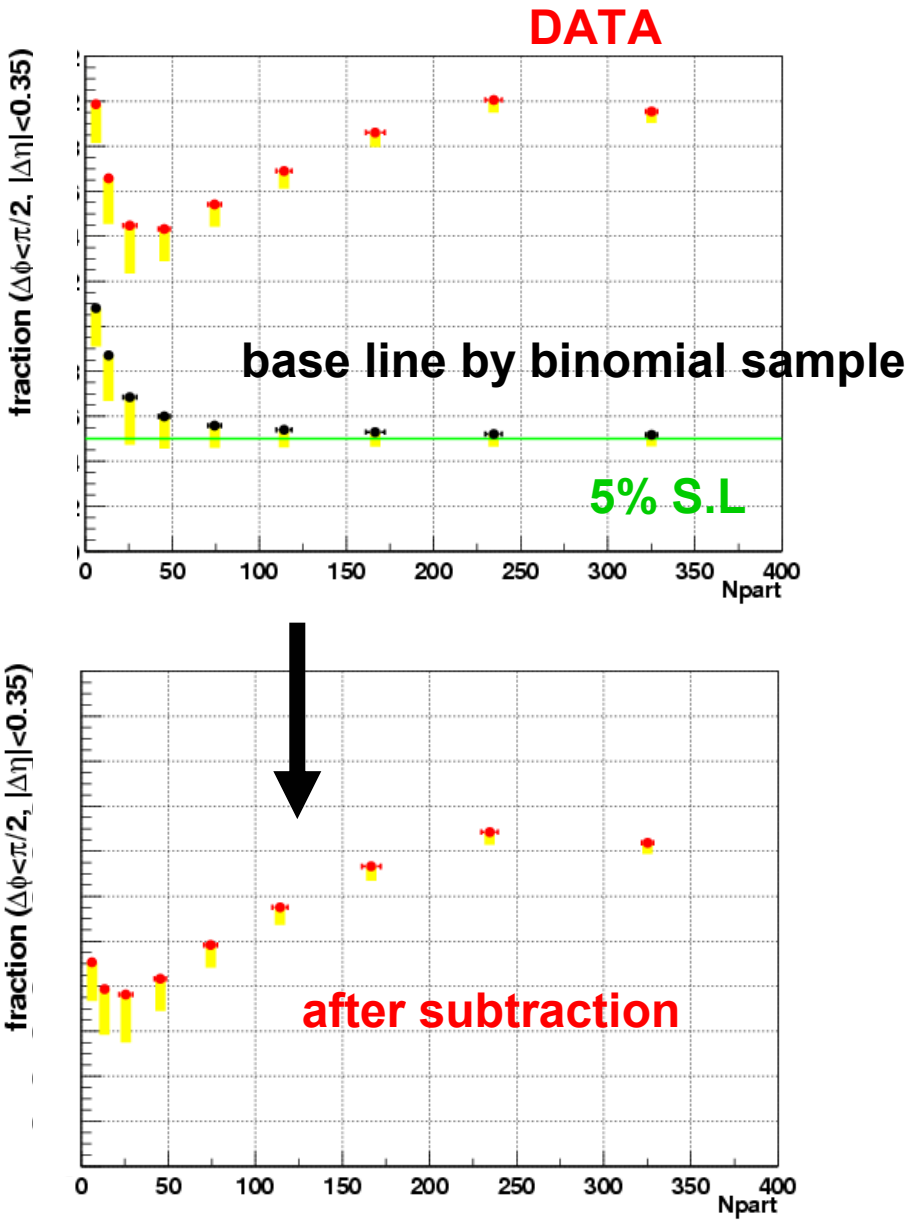
- Fraction of events above 5% significance level to exclude binomial fluctuation with respect to minimum bias events increases as N-participants increases.

- Known fluctuations measured by the other experimental observables in our experiment will be parameterized and tested by our observable separately to investigate the source of fluctuations.
  - Jets : two particle correlations and mean pT fluctuation
  - Flow effect (would be negligible): V2 analysis
  - Bose-Einstein correlation : subdivided multiplicity distributions with Negative Binomial Distribution

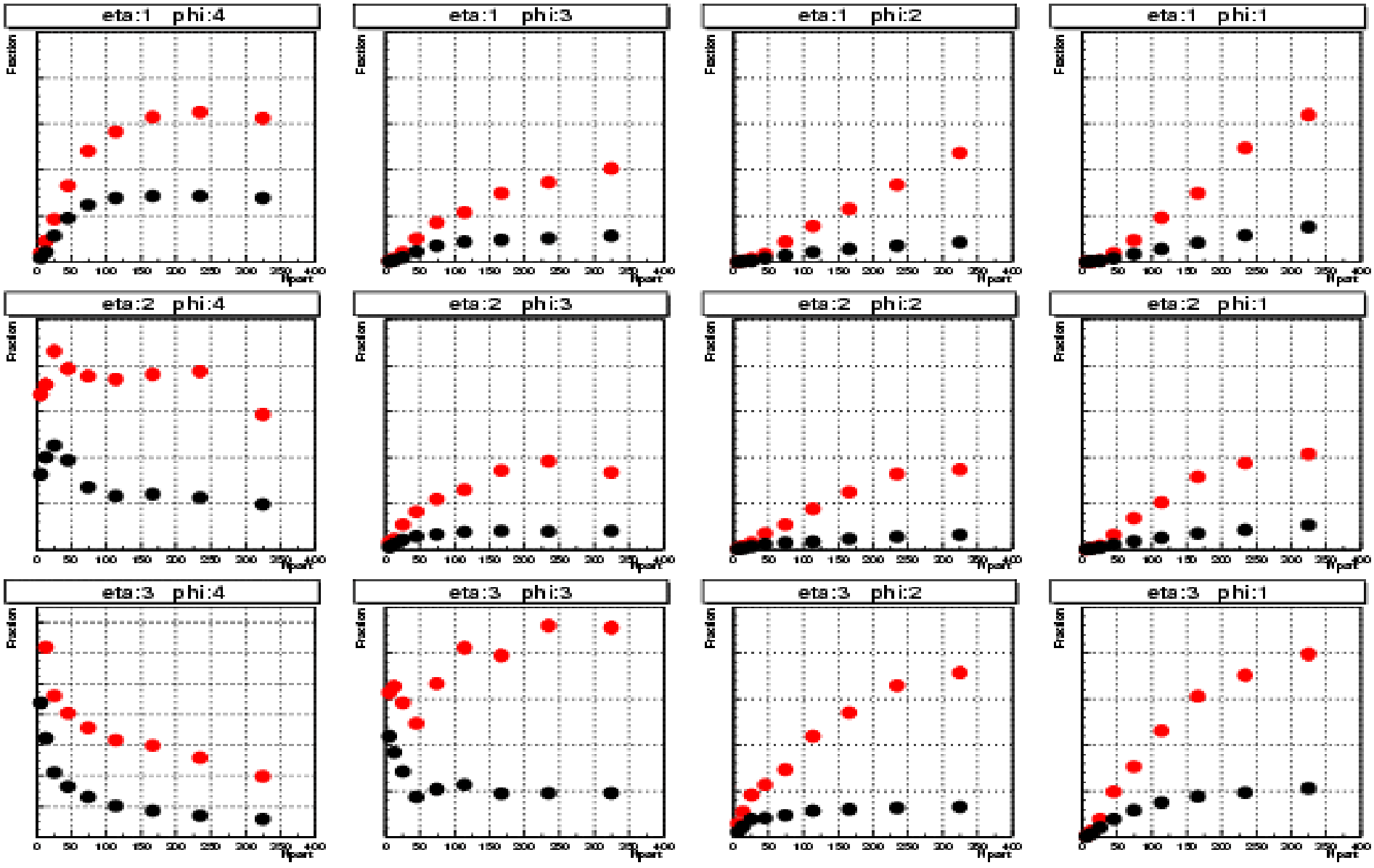
Back up slide

Baseline fluctuation

- Yellow band is one of the systematic error coming from ambiguity of limit value as 95% significance level.
- Baseline fluctuation have also a feature of enhancement of fraction at the low multiplicity events and at small resolution level. This algorism can not select large window at the low multiplicity. This is a feature of nature. So we subtracted the baseline fluctuation made by binomial based on hit map.

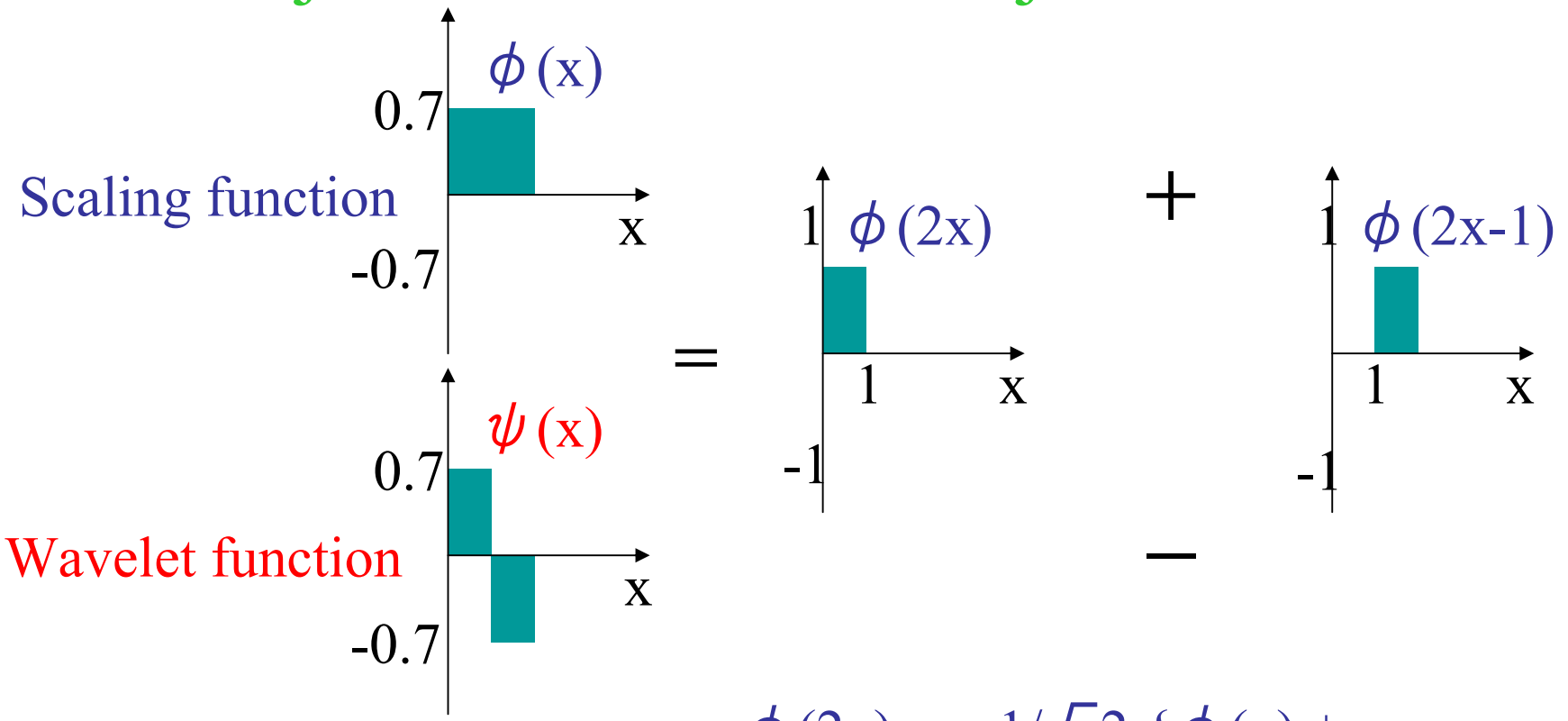


level-by-level



wavelet algorism (2 scale relation)

Level j-1 : 2^{j-1} bins Level j : 2^{j} bins



$$\phi(2x) = 1/\sqrt{2}\,\{\phi(x) + \psi(x)\}$$

$$\phi(2x-1) = 1/\sqrt{2}\,\{\phi(x) - \psi(x)\}$$

Multi resolution analysis

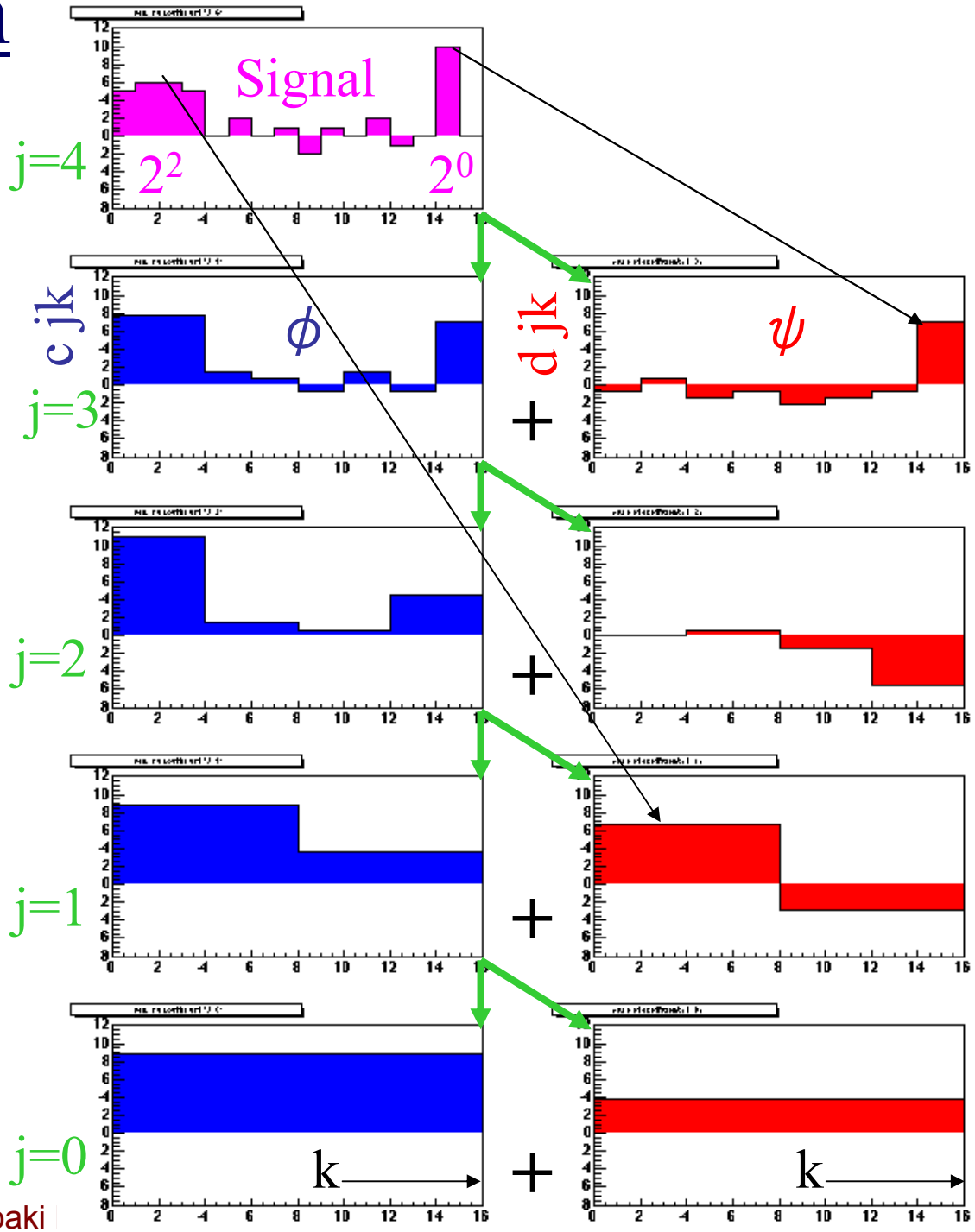
j : resolution level (domain size)

k : k-th bin in rapidity

c jk : coefficients of ϕ

d jk : coefficients of ψ

d jk corresponds to subtraction between two neighboring bins except scaling factor



Window shift

Shift the start bin at each resolution level.

Find djk max among all of levels.

This can determine the level (domain size) with the largest deviation size.